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ABSTRACT

In order to determine the magnitude and nature of relationships among selected measures of cognitive styles, abilities, and aptitudes, 24 tests were administered to 201 Navy recruits. The resultant data demonstrate that cognitive styles are relatively independent of abilities and aptitudes. Although styles were significantly related to abilities and aptitudes, the amount of shared variance was not large enough to be of practical importance. Abilities were significantly associated with aptitudes, having a considerable amount of variance in common. Three significant factors--technical apptitude, verbal ability, and problem-solving mode--were found to underlie much of the variability of cognitive characteristics. Educators should consider designing instructional strategies that take into account student differences in abilities, aptitudes, and cognitive styles; it seems likely that students would benefit by learning more readily, retaining information more easily, and retrieving information from memory with greater facility. (Author/CS)

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Are Cognitive Styles Independent of Abilities and Aptitudes?

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Problem

Cognitive styles refer to the dominant modes of information processing which people typically employ when perceiving, learning, or problem solving, e.g. field independence. Test of abilities allude to the intellectual capabilities of individuals which are general and pervasive to the performance of many tasks, e.g. verbal comprehension. Measures of aptitudes are used to select personnel to perform tasks which demand specific skills and to find the right person for a certain job. These tests assess specific content or skill, e.g., mathematics or mechanics, and they serve chiefly as classification instruments for making job decisions and school assignments for individuals.

Some dispute has been reported in the relevant research literature (Kogan, 1971; Satterly, 1976; Veron, 1972) regarding the differentiation or separability of cognitive styles from abilities and aptitudes. One line of thought claims that cognitive styles are not distinct from abilities and aptitudes; whereas, the other line of thought emphasizes that cognitive styles are independent of abilities and aptitudes. An important question that must be answered is whether these measures provide complementary or

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redundant information regarding students' cognitive characteristics for the purpose of predicting their school performance and prescribing instructional strategies to them.

Objective

The objective of this research was to determine the magnitude and nature of the relationships among selected measures of cognitive styles, abilities, and aptitudes.

Approach

Subjects

The subjects were 201 recruits from the Naval Training Center, San Diego. They were administered 12 tests. Six were designed to measure their cognitive styles, and six their abilities. When these individuals entered the service their aptitudes were measured by the 12 subtests of the Armed Services Vocational Aptitude Battery (ASVAB).

Cognitive Measures

Table 1 presents the 24 tests used in this study, along with the abbreviation and a brief description of each. The six tests designed to measure cognitive styles were selected because of their implications for

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adaptive instruction (Kogan, 1971); and the six tests designed to measure abilities, because they represent various types of information-processing tasks (Carrol, 1974, 1975). The ASVAB subtests were selected as measures of aptitudes not only because they are readily available for Navy personnel but also because they are used as a basis of assigning personnel to different Navy schools. All of the tests are (1) relatively independent, (2) moderate

to high in reliability, (3) paper-and-pencil in nature and (4) fairly short in duration.

Analyses

The relationships between measures of (1) cognitive styles and abilities, (2) styles and aptitudes, and (3) abilities and aptitudes were examined by computing three canonical analyses. A principal-factor analysis with iteration followed by an orthogonal varimax rotation was also computed for all 24 attributes, i.e., 6 cognitive styles, 6 abilities, and 12 aptitudes.

Results

Styles and Abilities

The three canonical analyses indicated the following. Cognitive styles were significantly related to abilities (R_c = .46; λ = .21; Λ = .69; $\chi^2(36)$= 71.07; ρ = .000). However, the amount of variance they shared in common was merely 21 percent. The canonical variates revealed that the more important measures contributing to the maximum relationship possible between these two sets of student characteristics in order of saliency were the cognitive styles field independence, category width, reflection-impulsivity, and conceptualizing style as well as the abilities induction, general reasoning, and verbal comprehension. The canonical loadings indicated that low scores on the salient cognitive styles were related to low scores on the prominent abilities with the exception of reflection-impulsivity.

Styles and Aptitudes

Cognitive styles were also significantly associated with aptitudes (R_c = .43; λ = .19; Λ = .61; $\chi^2(72)$ = 94.04; ρ = .039). The amount of variance these two sets of indices had in common is only 19 percent. The canonical variates disclosed that the consequential contributors to the

maximum feasible correlation between these two sets of measures were the cognitive styles field independence and conceptualizing style as well as the aptitudes mathematics knowledge, mechanical comprehension, shop information, and word knowledge. The respective canonical loadings for these important indices suggested that low field independence and conceptualizing style were associated with low mathematics knowledge and mechanical comprehension as well as high word knowledge and shop information.

Abilities and Aptitudes

It was established too that cognitive abilities were significantly related to aptitudes, and these measures share 68 percent common variance. The first canonical variate pair (R_c = .64; λ = .41; Λ = .33; $\chi^2(72)$ = 213.19; ρ = .000), which accounted for 41 percent of the variance of the maximum possible relationship between these two sets of tests, suggested that the prominent measures contributing to this association were the cognitive abilities verbal comprehension and general reasoning as well as the aptitudes word and mathematics knowledge. The loadings for the important indices of the first canonical variate pair revealed that low verbal comprehension and general reasoning were related to low word and mathematics knowledge. The second variate pair (R_c = .52; λ = .27; Λ = .56; $\chi^2(55)$ = 112.55; ρ = .000), which was orthogonal to the first and accounted for 27 percent of the variance of the canonical correlation, indicated that the salient indices contributing to this relationship were the abilities general reasoning, verbal comprehension, and induction as well as the aptitudes word knowledge, mechanical comprehension, arithmetic reasoning, and numerical operations. The loadings for the salient measures of the second canonical variate pair pointed out that high verbal and low general reasoning abilities were associated with high word knowledge

and low mechanical, arithmetic, and numerical aptitudes.

Initial Principal-Factor Solution

The estimated communalities of the cognitive characteristics for the initial unrotated principal-factor solution revealed the following. Aptitudes generally had larger communalities than abilities, which in turn, had larger communalities than styles. More of the total variance of individual aptitudes was accounted for by the combination of all initially derived principal factors than the total variance of individual abilities or styles. Aptitudes seemed to share more common variance with the other cognitive characteristics than either abilities or styles. Twenty-four factors were extracted which accounted for 100 percent of the variance of the cognitive characteristics. Of these, eight significant factors (those having associated eigenvalues equal to or greater than one) explained 62.2 percent of the variance. Aptitudes loaded factor 1, the most important component accounting for 21 percent of the variance, more than abilities which contributed more to this dimension than styles. The first unrotated factor then represented an aptitude-ability underlying dimension. The other factors because of the nature of their loadings and bipolarity were difficult to interpret. Consequently, the initial principal-factor matrix was rotated to achieve a more simple structure and meaningful pattern.

Terminal Varimax Factor Solution

For the terminal rotated orthogonal varimax solution too aptitudes had larger communalities than abilities, which in turn, had larger communalities than styles. Eight rotated factors accounted for 100 percent of the variance of the cognitive characteristics for this final factor solution. Three

significant factors explained 67.5 percent of the variance. Aptitudes loaded factor 1, the most important component accounting for 43.8 percent of the variance, more than abilities or styles. In order of prominence according to the magnitude of their respective loadings, the most salient measures contributing to this technical aptitude dimension were shop information, automotive information, mechanical comprehension, electrical information, general science, general information, and word knowledge. Abilities loaded factor 2, the next important component explaining 13.7 percent of the variance, more than aptitudes or styles. The most prominent indices loading this dimension were associational fluency, ideational fluency, and verbal comprehension. Factor 2, then, represented a verbal ability dimension. Some styles, abilities, and aptitudes had large loadings on factor 3 which accounted for 10 percent of the variance. The most important cognitive characteristics contributing to this component in order of prominence were field independence, induction, mathematics knowledge, reflection-impulsivity, electrical information, conceptualizing style, and general reasoning. Factor 3, therefore, denoted a problem-solving-mode dimension.

Discussion and Conclusions

In this study the principal-factor analysis and varimax rotation established the separability of cognitive style from technical aptitude and verbal ability. Measures of cognitive style, primarily field independence, reflection-impulsivity, and conceptualizing style, substantially contributed to the problem-solving-mode factor and not the technical aptitude or verbal ability factors. This is somewhat similar to Satterly's (1976) finding from a principal-component analysis with varimax rotation which established the distinctiveness of cognitive style (field independence, preference for analytical style, speed and flexibility of closure) from the factors

of general ability (English comprehension, picture vocabulary, verbal intelligence, and mathematics attainment), spatial ability (spatial dimension, judgment, speed, and flexibility of closure), and perceptual speed (perceptual ability and speed, flexibility of closure, and spatial judgment). However, the results of the present investigation are different from the findings of Vernon (1972) who demonstrated that measures of cognitive style or field-independence do not define a dimension distinct from general intelligence and spatial ability factors (which were defined by the following tests -- Copying Figures, Paper Formboard, Kohs Blocks, Concealed Figures, Embedded Figures, and Draw-a-Person Body Sophistication).

Two of the canonical analyses showed that the amount of shared variance between cognitive styles and abilities as well as cognitive styles and aptitudes is too little to be of practical importance. The small but statistically significant relationships obtained between the linear combinations of these measures indicated the relative independence of cognitive styles from abilities and aptitudes. This was also somewhat manifested by the principal-factor analysis and varimax rotation. Being orthogonal and having practically no overlap among the derived dimensions, the three significant terminal factors provide complementary -- not redundant -- information regarding students' cognitive characteristics. Technical aptitude is undoubtedly differentiated and separate from verbal ability as well as problem-solving mode. No amount of variance seems to be common to these distinct factors. Measures of technical aptitude are independent from verbal ability and problem-solving mode.

The distinctiveness or separability of styles from abilities and aptitudes has instructional significance. All three types of measures -- styles,

abilities and aptitudes -- should be considered with respect to possibly adapting alternative teaching techniques to cognitive attributes of students in order to improve their performance and achievement (Cronbach & Snow, 1977; Federico, 1978, in press; Federico & Landis, 1979a, b; Kogan, 1971). By designing distinct instructional strategies to take into account the differences among students in their cognitive styles, abilities, and aptitudes, it seems likely that they may (1) learn facts, concepts, principles, and rules more readily, (2) retain these specific types of knowledges more easily, and (3) retrieve material from memory with more facility.

It was concluded that measures of cognitive style are significantly related to abilities and aptitudes. Nevertheless, the amount of shared variance between styles and abilities as well as styles and aptitudes is not large enough to be of practical importance. It was established too that abilities are significantly associated with aptitudes, and these measures have a considerable amount of variance in common. Also, three significant factors were extracted (i.e., technical aptitude, verbal ability, and problem-solving mode) which underlie much of the variability of these cognitive characteristics. The data demonstrated that cognitive styles are relatively independent from abilities and aptitudes.

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Table 1

Cognitive Characteristics Measured

Cognitive Characteristic	Abbreviation	Description	Measurement Instrument
		Cognitive Style	
Field-Independence vs. Field-Dependence	FILDINDP	Analytical vs. global orientation	Hidden Figures Test, Part I (Ekstrom, French, Harmen, & Dermen, 1976)
Conceptualizing Style	CONCSTYL	Span of conceptual category	Clayton-Jackson Object Sorting Test (Clayton & Jackson, 1961)
Reflectiveness--Impulsiveness	REFLIMPL	Deliberation vs. impulse	Impulsivity Subscale from Personality Research Test, Form E (Jackson, 1974)
Tolerance of Ambiguity	TOLRAMBQ	Inclined to accept complex issues	Tolerance of Ambiguity Scale from Self-Other Test, Form C (Rydell & Rosen, 1966)
Category Width	CATEWIDH	Consistency of cognitive range	Category Width Scale (Pettigrew, 1958)
Cognitive Complexity	COGCOMPX	Multidimensional perceptions of the environment	Group Version of Role Construct Repertory Test (Bieri, Atkins, Briar, Leaman, Miller, & Tripodi, 1966)
		Cognitive Ability	
Verbal Comprehension	VERBCOMP	Understanding the English language	Vocabulary Test, Part I (Ekstrom et al., 1976)
General Reasoning	GENLREAS	Solving specific problems	Arithmetic Aptitude Test, Part I (Ekstrom et al., 1976)
Associational Fluency	ASSOFLUN	Producing similar words rapidly	Controlled Associations Test, Part I (Ekstrom et al., 1976)
Logical Reasoning	LOGIREAS	Deducing from premise to conclusion	Nonsense Syllogisms Test, Part I (Ekstrom et al., 1976)
Induction	INDUCTON	Forming hypotheses to fit certain facts	Figure Classification Test, Part I (Ekstrom et al., 1976)
Ideational Fluency	IDEAFLUN	Generating ideas about a specific type	Topics Test, Part I (Ekstrom et al., 1976)
		Cognitive Aptitude	
General Information	GENLINFO	Recognizing factual information	General Information Subtest, ASVAB
Numerical Operations	NUMROPER	Completing arithmetic operations	Numerical Operations Subtest, ASVAB
Attention to Detail	ATTNDETL	Finding an important detail	Attention to Detail Subtest, ASVAB
Word Knowledge	WORDKNOL	Comprehending written and spoken language	Word Knowledge Subtest, ASVAB
Arithmetic Reasoning	ARTHREAS	Solving arithmetic word problems	Arithmetic Reasoning Subtest, ASVAB
Space Perception	SPACPERC	Visualizing objects in space	Space Perception Subtest, ASVAB
Mathematics Knowledge	MATHKNOL	Employing mathematical relationships	Mathematics Knowledge Subtest, ASVAB
Electronics Information	ELECINFO	Using electronics relationships	Electronics Information Subtest, ASVAB
Mechanical Comprehension	MECHCOMP	Reasoning with mechanical concepts	Mechanical Comprehension Test, ASVAB
General Science	GENLSCIE	Perceiving relationships between scientific concepts	General Science Subtest, ASVAB
Shop Information	SHOPINFO	Knowing shop tools	Shop Information Subtest, ASVAB
Automotive Information	AUTOINFO	Knowing automotive functions	Automotive Information Subtest, ASVAB

Note. These cognitive characteristics and the tests used to measure them are described in detail in Federico and Landis (1979) (Appendix).